

# Take-aways from SC A3

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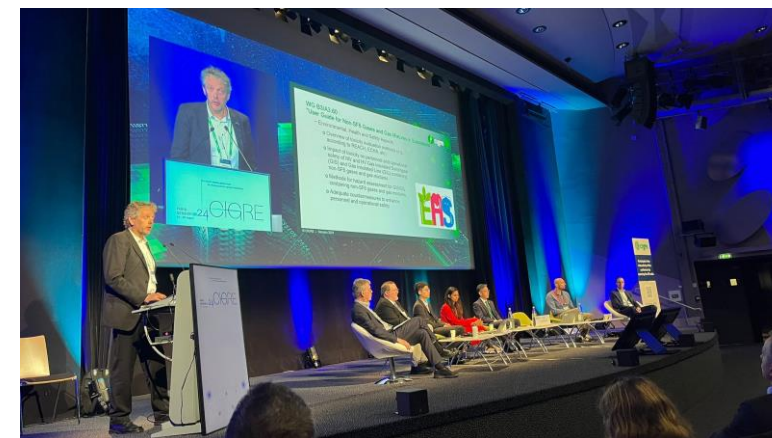


**cigre**

For power system expertise

## CIGRE Paris events A3 in a nutshell

- T&D equipment (switchgear, instrument transformers, insulators)
- Submitted reports (78 reports, 2 NL)
- Tutorial: Application of generator circuit breakers in power plants (203 att)
- Poster session (80 posters, 1389 att)
- Workshop “Driving T&D Substations and Equipment towards Zero Emissions” with A2, B3, C3, D1 (9 speakers, 7 panellists, 514 att)
- Group Discussion Meeting (62 speakers, 478 att)



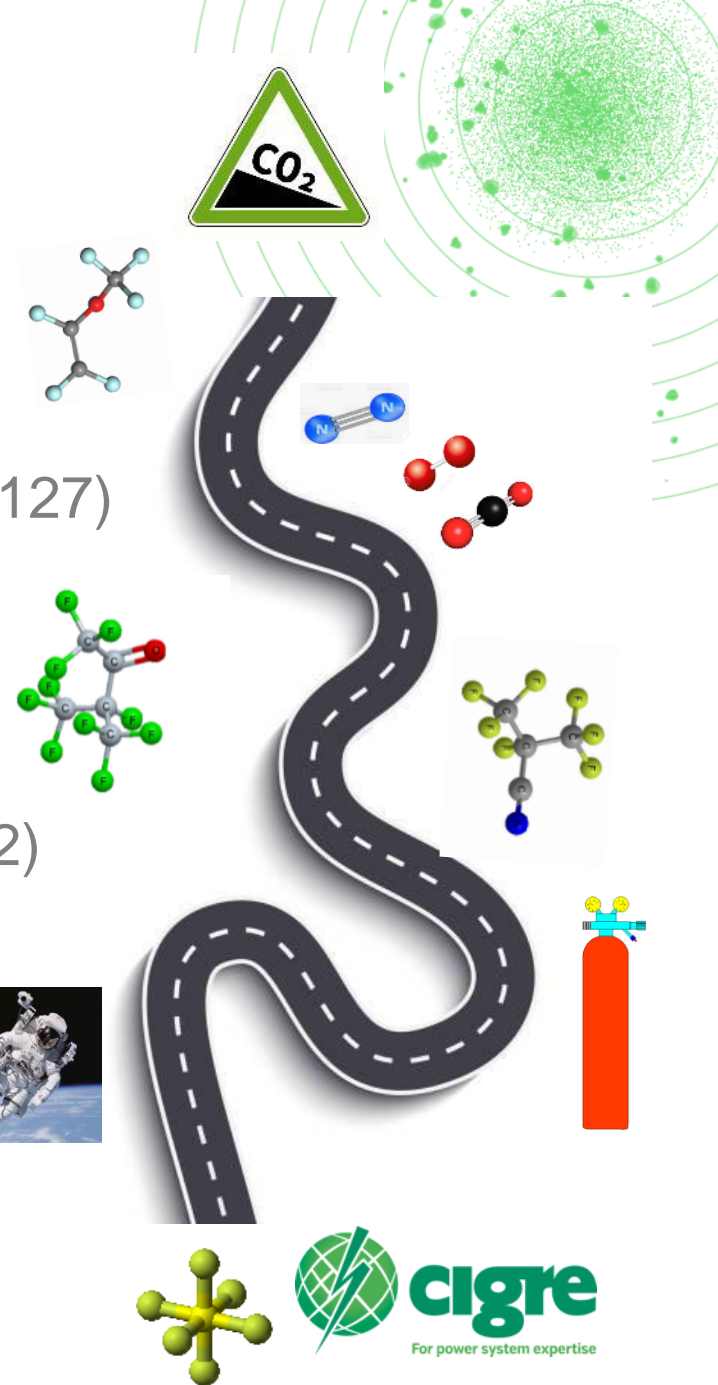


# SF<sub>6</sub> replacement & LCA

A3: 26 reports; (B3: 9; D1: 3)

- Six European TSOs may need 1000 t SF<sub>6</sub> until 2032 (10917)
  - 25 projects/pilots running/planned with C4-FN mix, vacuum+air, CO<sub>2</sub>+O<sub>2</sub>
- 420 kV 63 kA C4-FN switchgear soon in operation (10718,10127)
  - 245 kV 50 kA single-break spin-off coming soon
- TSO's experiences with installation, retrofill, testing (10740) with C4-FN based HV switchgear of 170 kV and below
  - comparison of three technologies (10309)
- Earthing/disconnector switches in 420 kV vacuum GIS (11042)
  - vacuum circuit breaker in development
- Application of HV vacuum GIS
  - 72/84 kV GIS lifetime performance evaluations (11092, 10308)

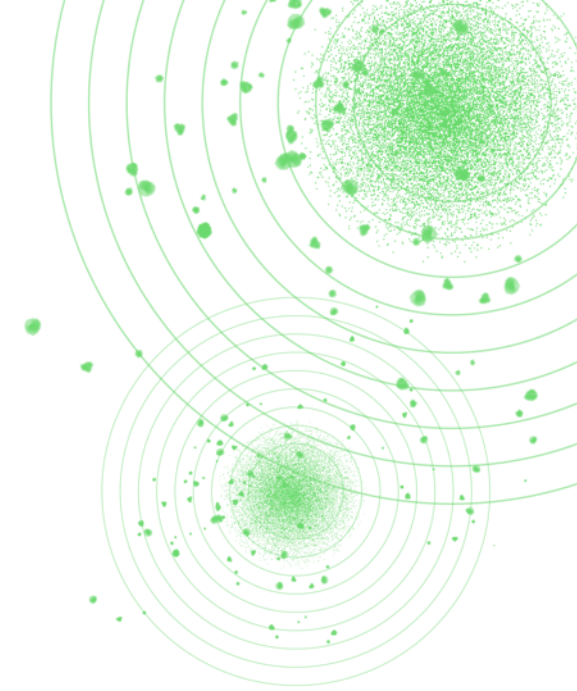
Significant number of reports deal with LCA (Life Cycle Assessment) comparing C4-FN mixtures with SF<sub>6</sub> and with vacuum + compressed air technology (11261, 10721)



# Asset management, monitoring and diagnostics

16 reports

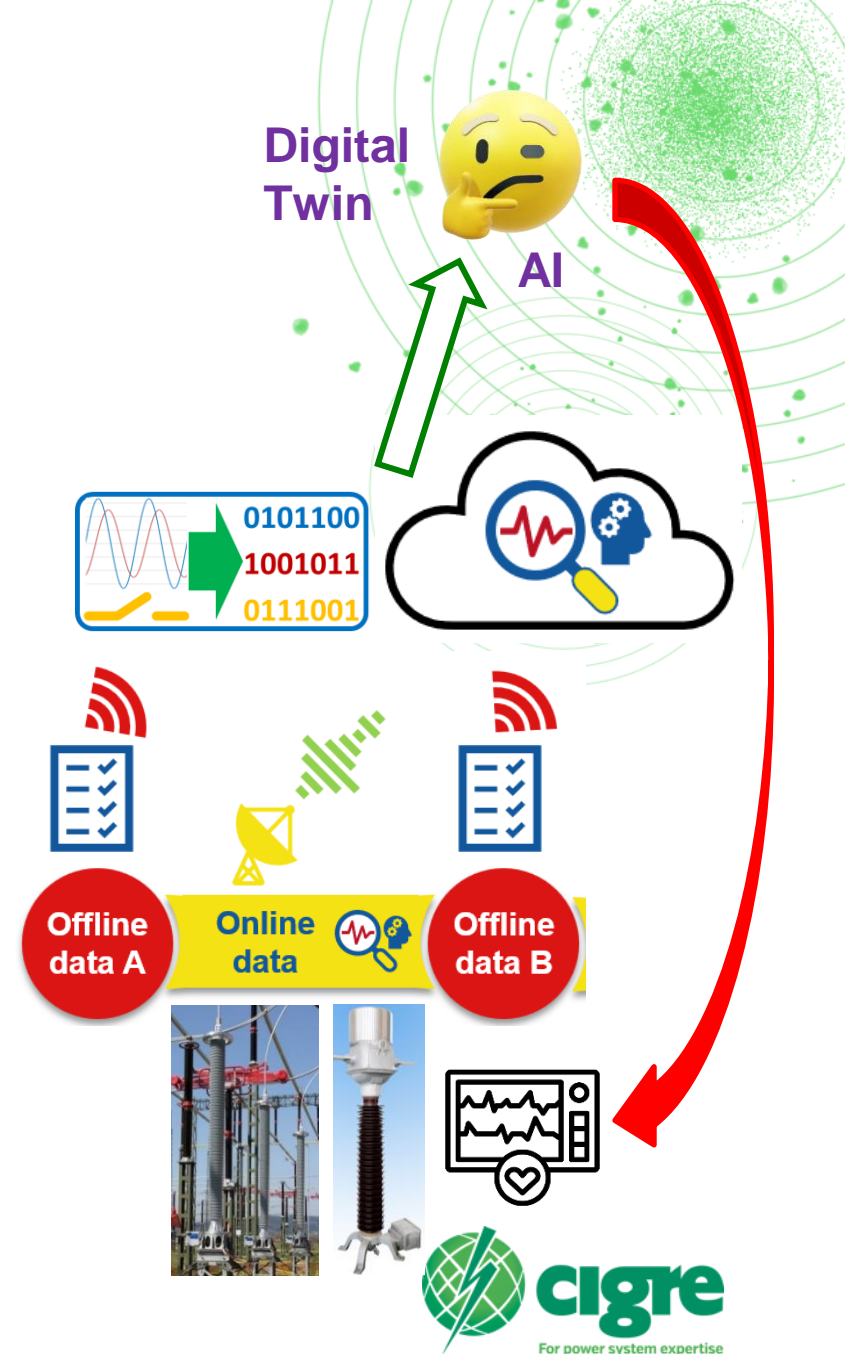
- Dominant topic: Centralized asset management centres
- Extensive use of condition monitoring, health index assessment
  - 10324, 10325, 11015
- Digital twin modelling, input collected from IoT data (11150)
- Data sharing
  - failure catalogue across different companies and different countries of the same TSO (11148).
- Experience of diagnostic based on monitoring data and automated evaluation.
  - technical competence can still make a difference for advanced complex diagnostic (11337, 11269).
- Technical innovation: Completely non-intrusive breaker monitoring systems
  - based on measurements from electric field sensors, piezoelectric sensors, radio-frequency antennas and AC clamps for trip/close coil current (11637, 11855).



# Instrument transformers and digitalization

A3: 19 reports (B3: 2; B5: 5; D1: 1)

- LPITs, new technical solutions developed (10132)
  - more grid experience gained (11333)
- Conventional ITs ready for new grid applications (10579)
  - alternative insulation system developments (11682, 10580)
  - failures of CTs due to PD (10715)
- Monitoring of physical grid data (11494)
  - partial discharge data, power quality data from DC to HF (10584)
- Development of suitable models of various types of ITs
  - for new applications and digital twin solutions (11154)
- Data analysis using AI, ML
  - for condition & predictive monitoring of the assets, health index, lifetime evaluations etc. (10581, 11847, 10578)



# Miscellaneous T&D equipment and systems

19 reports

- Countermeasure for increasing fault current is still an issue in expanding grids
  - Fast circuit breaker, superconducting fault current limiter (10188, 11830)
- Novel sensors and controllers improve switchgear functionality
  - Controlled switching recognized as an effective method in actual grids (11097, 11610)
- Study on arc phenomena drives development of CBs
  - Observation and control of plasma in vacuum interrupter (10165)
- DC Switching equipment steps up to the mature stage
  - HVDC circuit breaker (11259, 11900)
- Advanced insulators and conductors for AC & DC as vital components
  - Solid insulation: ceramic, silicone, resin impregnated (10321, 11851, 10162)

